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(54) A screw compressor control arrangement

(57) An arrangement for controlling screw compressors, in particular when starting and when idling, a throttle valve (4) being installed into the suction line (2) of the screw compressor (1) in order to regulate the amount conveyed. The throttle valve is by-passed by a by-pass line (12) with a by-pass valve (14), the passage cross-section of which can be adjusted in at least two stages, by means of a control device (15). For the starting process of the compressor (1), a larger passage cross-section can be opened and for idling, a smaller passage cross-section. In order to prevent the medium from flowing back through the by-pass line (12) against the suction direction, a check valve (13) is installed into the by-pass line (12). In the by-pass valve shown in Figure 3, a loose ball (22) replaces the check valve (13), the ball being moved adjacent seat (20) to provide a small cross-section.

FIG.1

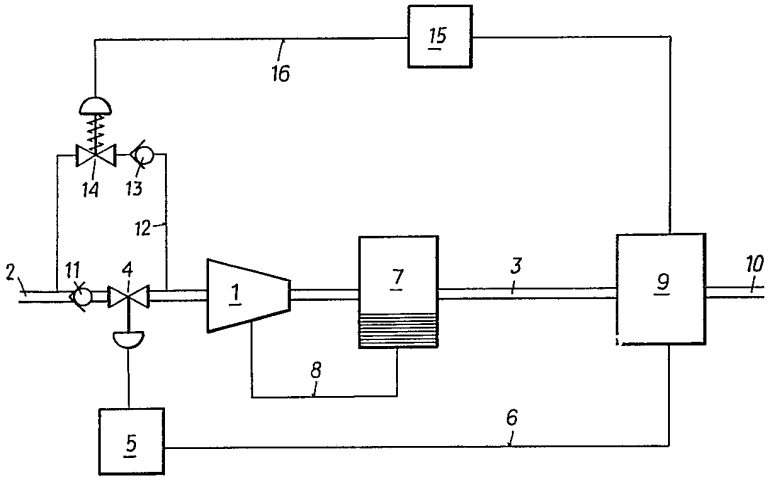
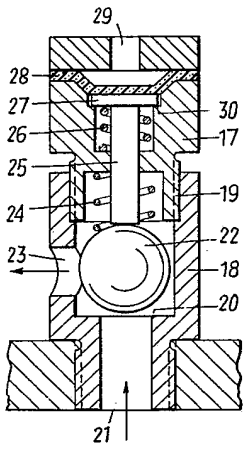


FIG.3



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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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FIG. 1

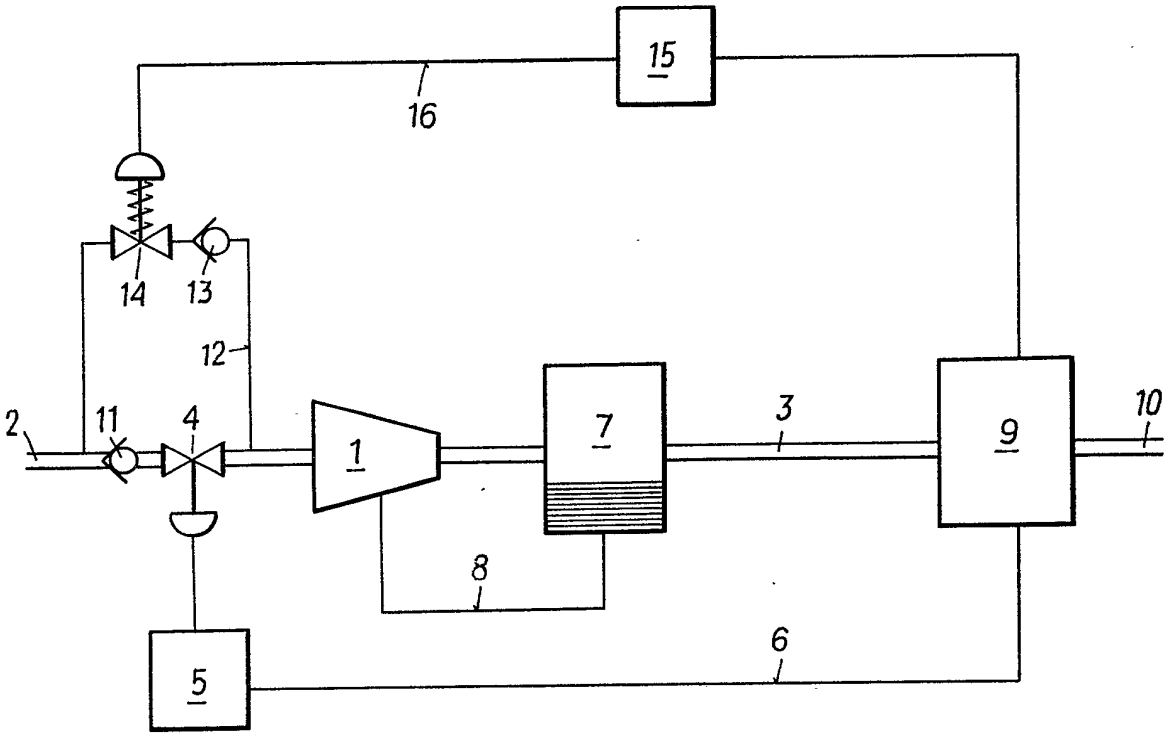


FIG. 2

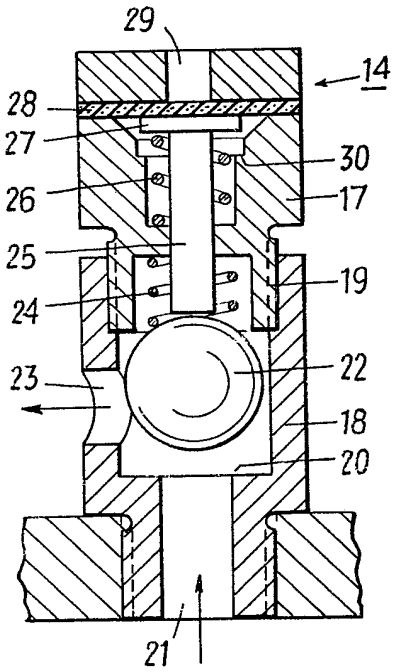
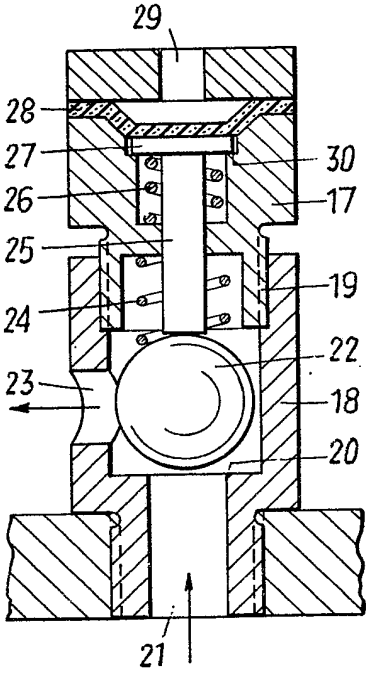


FIG. 3



SPECIFICATION

A Screw Compressor Control Arrangement

The invention relates to a screw compressor control arrangement for controlling a screw compressor, in particular when starting and for regulating idling, comprising a throttle valve installed into the suction line of the screw compressor for regulating the amount delivered and a by-pass valve which is installed into a by-pass line which passes around the throttle valve.

When regulating the amount conveyed by a screw compressor by means of a throttle valve installed into the suction line, it is necessary to keep the throttle valve closed when starting, in order to avoid a sudden overloading of the compressor installation and also particularly of the drive motor. On the other hand, a passage cross-section of a specific size must be opened or kept open, so that a pressure can build up quickly, which is necessary for cooling by fluid injection and for adjusting the throttle valve.

In order to keep the necessary passage cross-section open when the throttle valve is closed, it is known to form the throttle valve so as to be untight, ie by arranging an adjustable stop screw for the closing part of the throttle valve, in particular for the throttle flap, or a small passage opening in the throttle flap itself. These measures, however, cannot be used for compressor installations which are constantly under mains pressure, ie in which the check valve preventing the return flow of the compressed medium is disposed in the suction line and not behind the compressor in the pressure line, because in these installations the suction line with an upright compressor must be tightly sealed. Furthermore, the fact that the passage cross-section of these passage openings cannot be adapted to different operating states of the compressor is a disadvantage.

Similar disadvantages also exist in the further known arrangement in which there is provided, as the by-pass valve, a solenoid valve which is opened whilst the screw compressor is started and is closed after starting. Moreover, in this arrangement additional electric devices are necessary for controlling the solenoid valve.

The basic object of the invention is to improve the known arrangements for controlling screw compressors in such a way that in an upright compressor the suction line is securely sealed, whereas during starting and idling, passage cross-sections of varying sizes through the by-pass valve are opened.

This problem is solved by means of the invention in that the passage cross-section of the by-pass valve can be adjusted in at least two stages and a check valve is installed into the by-pass line and blocks a return flow through the by-pass line against the suction direction. By using a by-pass valve formed in this way, when the suction line is tightly sealed by the throttle valve used to regulate the amount conveyed, it is simple for a relatively large passage cross-section to be opened by way of the by-pass line when starting the compressor, which cross-section makes a rapid pressure build up possible, and a sufficient throttle effect is obtained during idling by decreasing the passage cross-section in order to obtain an underpressure and a low power consumption, associated with the latter, by the drive motor. The check valve installed into the by-pass valve prevents the compressed medium from flowing back into the suction line.

In a further development of the invention the by-pass valve can at the same time be constructed as a check valve. Then only one valve, which can carry out the desired task, is needed in the by-pass line.

In a preferred embodiment of the invention the by-pass valve has a closing part which preferably consists of a ball and is pressed by a return spring onto its valve seat opposite a stroke stop which can be moved in the opening direction of the closing member. This is a simple valve structure which consists virtually only of rotatable parts and can fulfill all the requirements within the scope of the arrangement according to the invention. In this connection the stroke stop can consist of a stem which is displaceably guided in the valve housing and can be moved in the opening direction of the closing member by a spring and against the force of the spring by way of a membrane or a piston by a pressure medium. In this way simple actuation of the by-pass valve is also possible.

The arrangement according to the invention can be further developed in that the passage cross-section of the by-pass valve can be adjusted by a control device in dependence on the mains pressure prevailing behind the compressor, it being possible to select a larger passage cross-section for the starting process of the compressor and a smaller, preferably adjustable passage cross-section for idling. In this connection, when the operating state of the compressor changes, the by-pass valve also switches automatically to the passage cross-section necessary for the particular operating state, eg for starting or for idling. In addition to this switching, another possibility of adjusting the passage cross-section may also be provided, eg by screwing sections of the valve casing together.

The invention will be described by way of example with reference to the drawings wherein:-

Figure 1 shows the schematic circuit diagram of a compressor installation, which is provided with a control arrangement embodying the invention; and

Figures 2 and *3* show a by-pass valve in the control arrangement of Figure 1 in various switch positions in the axial cross-section.

The compressor installation shown in Figure 1 consists of a screw compressor 1, whose suction line is designated with 2 and whose pressure line is designated with 3. Into the suction line 2 there is installed a throttle valve 4, which is used to regulate the amount conveyed and is adjusted by a regulating device 5, to which the pressure of the compressed medium, as the regulating quantity is fed by way of a regulating line 6. Firstly an oil container 7, from which an oil injection line 8 leads back to the compressor 1, is inserted into the pressure line 3 behind the compressor. In addition, a pressure container 9, from which the the service line 10 leads off, is inserted into the pressure line 3.

The throttle valve 4 and a check valve 11, also

inserted into the suction line 2, are bridged by a by-pass line 12 likewise into which a check valve 13 and a by-pass valve 14 are installed. The by-pass valve 14 can be adjusted by means of a control device 15, which is incorporated into a control line 16 which is guided from the pressure container 9 to the by-pass valve 14.

Figures 2 and 3 show an embodiment of the by-pass valve 14. The latter has a valve casing consisting of two housing sections 17 and 18, which are screwed together by a thread 19. In the lower housing section 18 there is a valve seat 20 with a through duct 21, which is controlled by a ball 22 as the valve closing part. An outlet duct 23 is disposed laterally in the lower housing section 18. The ball 22 is loaded with a weak return spring 24, which presses the ball onto the valve seat 20. The opening stroke of the ball 22 is restricted by a stem 25, which in the upper housing section 17 is displaceably guided against the force of a spring 26, and with a widened headpiece 27 bears against a membrane 28. By supplying a pressure medium though a control duct 29, the membrane 28 can be moved downwards towards the stem 25 until the headpiece 27 comes to rest against a stop 30 in the upper housing section 17, as is shown in Figure 3.

The mode of operation of the described arrangement is as follows: When starting the screw compressor shown in Figure 1, the throttle valve is firstly closed. When the compressor installation is pressureless, eg when starting for the first time or after having stopped for a long time, the throttle valve 4 cannot be opened either, because, in the pressure container 9, the medium does not have the necessary pressure for actuating the throttle valve 4 by way of the regulating device 5. However, it is necessary to open a sufficiently large passage cross-section in the suction line quickly, so that an actuation pressure can build up and that lubrication of the compressor 1 from the oil container 7 by way of the oil injection line 8 is ensured. For this purpose, a by-pass line 12 is provided. The by-pass valve 14 installed into the latter is constantly open so that the necessary passage cross-section for starting is available.

As can be seen from Figures 2 and 3, the opening stroke of the valve ball 22 of the by-pass valve 14 can be adjusted in two stages. When no pressure medium is fed through the control duct 29, the stem 25 is positioned in its upper end position so that the valve ball 22 can carry out its complete stroke and the by-pass valve 14 releases a correspondingly large passage cross-section. On the other hand, if a pressure medium is fed through the control duct 29, the stem is moved downwards according to Figure 3, as a result of which the stroke of the valve ball 22 and in connection with this also the passage cross-section through the by-pass valve 14 is diminished. The described adjustment of the passage cross-section of the by-pass valve 14 takes place in the arrangement acording to Figure 1 by means of the control device 15 in dependence on the respective pressure in the pressure container 9.

When the pressure container 9 is pressureless or has a relatively slight pressure, the control duct 29 of the by-pass valve 14 is also pressureless, so that the latter releases the larger passage cross-section. The by-pass valve 14 takes up this position when the compressor 1 is at a standstill or is about to be started. The by-pass valve 14 then releases a sufficiently large passage cross-section during the starting process, for as long as the throttle valve 4 remains closed, in order to ensure a rapid build-up of pressure and adequate lubrication of the compressor 1. When, as the pressure rises in the pressure container 9, the desired maximum pressure is obtained, the compressor 1 is switched to idling. The throttle valve 4 is closed during idling. The suction line 2, however, must not be completely sealed since otherwise the compressor 1 would not be adequately lubricated. The remaining suction cross-section should, however, be as small as possible, at any rate smaller than the suction cross-section when starting the compressor installation. In order to achieve this, the by-pass valve 14 is switched by the control device 15 to the position shown in Figure 3, in which the stem 25 is in its lower end position and the stroke of the valve ball 22 is correspondingly decreased. The exact size of the desired passage cross-section through the by-pass valve 14 can be set exactly by screwing the housing sections 17 and 18 together by means of the thread 19.

The medium sucked in flows in the direction of the arrows drawn in Figures 2 and 3 through the by-pass valve 14, both when starting and when idling. Since the valve ball 22 is loaded by the return spring 24 against the valve seat 20, the by-pass valve 14 acts at the same time as a return valve, which prevents the medium flowing back through the by-pass line 12. The by-pass valve 14 formed according to Figures 2 and 3, therefore, replaces the check valve 13 drawn in the by-pass line 12 in Figure 1, so that the check valve can be dispensed with.

CLAIMS

1. A screw compressor control arrangement for controlling a screw compressor in particular when starting and for regulating idling, comprising a throttle valve installed into the suction line of the screw compressor for regulating the amount conveyed and a by-pass valve, which is installed into a by-pass line passing around the throttle valve, characterized in that the passage cross-section of the by-pass valve can be adjusted in at least two stages and in that there is installed into the by-pass line a check valve, which blocks return flow through the by-pass line against the suction direction.

2. An arrangement according to claim 1, characterized in that the by-pass valve is formed as the check valve.

3. An arrangement according to claim 1 or 2, characterized in that the by-pass valve has a closing part, which is pressed by a return spring onto its valve seat, opposite which there lies a stroke stop which can be moved in the opening direction of the closing member.

4. An arrangement according to claim 3, characterized in that the stroke stop consists of a stem which can be displaceably guided in the valve housing and can be moved in the opening direction of the closing member by a spring and against the force of the spring by way of a membrane or a piston by a pres-

sure medium.

5. An arrangement according to claim 3 or 4, characterized in that said closing part of the by-pass valve consists of a ball.

6. An arrangement according to any one of claims 1 to 5, characterized in that the passage cross-section of the by-pass valve can be adjusted by a control device in dependence on the mains pressure prevailing behind the compressor, it being possible to select a larger passage cross-section for the starting process of the compressor and a smaller passage cross-section for idling.

7. An arrangement according to claim 6, characterized in that said smaller passage cross-section for idling is adjustable.

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